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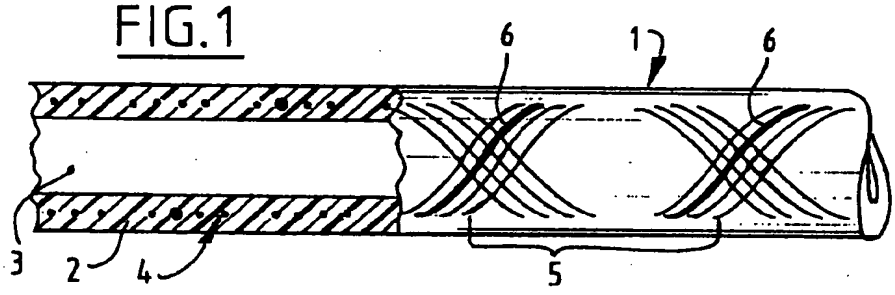
(54) MR-visible catheter with elements of paramagnetic material

(57) The invention relates to a catheter comprising a tube-like body with a proximal and a distal end and with at least one lumen. At least one element of paramagnetic material has been received in the catheter, for instance in the form of a braided reinforcing layer, wherein the elements of paramagnetic material are formed by at least some of the wires of the reinforcing layer and any remaining wires of which the reinforcing layer has been braided are made of non-magnetic material. The paramagnetic material can also have been received in the form of a marking ring arranged around the catheter. Consequently the position of the catheter inside the body of the patient can be made visible under NMR conditions.

FIG.1



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Description

The invention relates to a catheter for diagnostic and interventional purposes.

Such a catheter is introduced into the body of a patient by the physician carrying out the procedure. Via the vascular system of the patient, the distal end of the catheter is advanced to the site to be treated or investigated.

When doing so, the area surrounding the distal end of the catheter is made visible on a screen. This is done in the usual manner using X-rays.

The known catheters are consequently made in such a way that they are clearly visible when using X-rays. That is to say, they comprise marking elements made of metal or alloys which are substantially opaque to X-rays, so that their shadow becomes visible on the screen. Known marking elements are for instance marking bands or -rings arranged at certain positions around the catheter.

Catheters of the type comprising a reinforcing layer braided of metal wire are as such clearly visible when subjected to X-rays, as the wires of which the reinforcing layer has been made serve as marking elements.

With certain applications it is desirable however to form a picture by means of an NMR technique, known as such, rather than by using X-rays. However, catheters suitable for use in conjunction with X-ray imaging are not necessarily suitable for application in an NMR device.

The marking bands of the known catheters are usually made of for instance platinum or gold, and these metals will not be visible on a screen of an NMR device as they are non-magnetic.

Catheters with a reinforcing layer braided of metal wire cannot be used either, as the metal wire of the reinforcing layer usually consists of a ferrous metal. When using such a catheter in conjunction with an NMR device, the disturbance of the magnetic field will be such that the picture will be disturbed over a much greater section than the width of the catheter. It may be exceeded by a factor of 100. The areas adjacent to the position of the catheter will be "outshone" and will consequently be no longer visible.

The object of the invention is to provide a catheter of the type as described in the preamble which can be made visible in an NMR device in such a way, that both the position of the catheter and the areas adjacent to the catheter will be clearly visible on the screen.

This aim is achieved with a catheter as characterised in claim 1. The element of paramagnetic material disturbs the magnetic field in the NMR device only to a limited degree, so that good image formation is achieved without outshining the adjacent areas.

It should be noted that it is known as such from the American patent specification 5 154 179, to use paramagnetic materials for a catheter to be used in conjunction with an NMR device. According to that American patent specification these paramagnetic materials are used in a contrast medium received in a separate channel of the catheter. In many applications it is not possible however to make use of a contrast medium.

The preferred measure of claim 2 has the advantage that the visibility of the catheter is ensured respective of the direction of the magnetic field.

In this regard a suitable embodiment of the catheter according to the invention is characterised in claim 3. By choosing the number of wires made of paramagnetic material in a suitable manner, a correct degree of visibility of the catheter can be achieved. When a weak paramagnetic material is used, many or all wires can be made of that material. With stronger paramagnetic material less wires will be made of that material in order to achieve good visibility. Thus a suitable choice can be made considering cost price and strength of the reinforcing layer. The non-magnetic material can be a non-magnetic metal, but also a strong plastic material such as KEVLAR or TWARON.

The wires of paramagnetic material can be manufactured in a suitable manner of an alloy of non-magnetic material and strong paramagnetic material. Thus suitable tensile-strength properties and magnetic properties can be combined in the material.

The measure as set out in claim 5 can be employed in an advantageous manner.

Another embodiment of the invention is characterised in claim 6. The same method of construction can in this case be employed as for catheters which are to be made visible when subjected to X-rays. The usual marking rings made of gold or platinum are replaced by rings made of paramagnetic material. An additional advantage of using ringshaped elements of paramagnetic material, is that the visibility of the catheter provided with these elements is not dependent on the direction of the magnetic field relative to these elements.

A very advantageous embodiment is characterised in claim 6. This is a multipurpose catheter which can be used in conjunction with both X-rays and NMR techniques in order to make the area of the patient to be treated visible.

A suitable embodiment is characterised in claim 8. A paramagnetic material can be used which as such may be harmful to man and is therefore not allowed to come into contact with parts of the human body or body fluids. As the paramagnetic material is situated on the inside of the ring made of non-magnetic material, such contact is out of the question.

Another suitable embodiment is characterised in claim 11. The helically wound wire of paramagnetic material does not influence the flexibility of the catheter to a significant degree. Also this wire may have been made of a paramagnetic material which as such is not suitable for contact with the human body. As it is embedded in the material of which the catheter has been made, the wire cannot come into contact with the body.

Suitable materials are characterised in claim 12.

The invention will be explained in greater detail in the following description with reference to the attached drawings.

Figure 1 shows a partly cut away and broken away side view of part of a catheter with a reinforcing layer braided of metal wire, according to the invention.

Figure 2 shows a corresponding view of another embodiment of the catheter according to the invention.

Figure 3 shows a cross-section along the line III-III of figure 2.

Figure 4 shows a partly broken away view of an end-section of a catheter according to another embodiment of the invention.

The catheter 1 shown in figure 1 comprises in the usual manner a tube-like body 2 with a lumen 3. The catheter 1 is of the type comprising a reinforcing layer 4 braided of metal wire.

With this catheter one of the wires of which the reinforcing layer 4 has been braided, the one indicated with the number 6, has been made of paramagnetic material. The other wires 5 have been made of a non-magnetic material.

The wires 5 of non-magnetic material remain invisible under NMR conditions, whereas wire 6 made of paramagnetic material causes just enough disturbance of the uniformity of the magnetic field, to render the catheter visible on the screen.

The wire 6 has been made of an alloy of nonmagnetic material and strong paramagnetic material, more in particular an alloy of titanium and copper or nickel.

With other embodiments more than one or even all wires may have been made of paramagnetic material.

The catheter 10 of figure 2 also comprises a tube-like basic body 11 with a lumen 12. The body 11 comprises a plastic material commonly used for this purpose, such as for instance polyethene or polyurethane.

In the body 11 a depression 15 has been arranged in which two concentric rings 13, 14 have been received. The ring 13 has been made of paramagnetic material and the ring 14 of non-magnetic material. The rings 13 and 14 have been glued in the depression 15, so that they make up a whole with the basic body 11. The ring 13 made of paramagnetic material renders the catheter visible under NMR conditions, whereas the ring 14 made of non-magnetic material such as platinum or gold renders the catheter visible when subjected to X-rays. The catheter 10 can therefore be used universally, independent of the imaging technique employed.

With the illustrated embodiment of the catheter according to the invention, the paramagnetic material of which the ring 13 has been made can as such be harmful to man. As the ring 13 has been received fully enclosed both by the body 11 of the catheter and the ring 14, no direct contact between the body or body fluids and the paramagnetic material 13 can take place. The paramagnetic material of which the ring 13 is to be made can therefore be chosen freely in accordance with the optimum properties as regards the intended imaging under NMR conditions.

With another embodiment of the invention the ring of paramagnetic material can be made by depositing the paramagnetic material on the inside surface of a ring made of non-magnetic material by means of a deposition technique. Preferably, this deposition technique can be a sputter technique. Thus one single, easy to handle ring is obtained, simplifying the manufacturing process of the catheter.

With the catheter 20 of figure 4 another solution has been chosen for receiving an element of paramagnetic material in the catheter. With the catheter 20 this element is formed by a helically wound wire 23 which is embedded in the plastic material of the body 21 of the catheter 20.

Both on the outside and on the side of the lumen 22, the wire 23 is screened off by material of which the body 20 has been made, so that there is no objection to choose as paramagnetic material for the wire 23, material which has optimal properties where image formation under NMR conditions is concerned but which as such may be harmful to man.

By winding the wire in a helical fashion, it does not effect the flexibility of the end-section of the catheter 20.

Claims

1. Catheter comprising a tube-like body with a proximal and a distal end and with at least one lumen, in which at least one element made of paramagnetic material has been received.

2. Catheter as claimed in claim 1, wherein the element of paramagnetic material extends helically with regard to the tube-like body.

3. Catheter as claimed in claim 2, wherein the catheter is of the type comprising a braided reinforcing layer, the elements of paramagnetic material are formed by at least some of the wires of the reinforcing layer and any remaining wires of the reinforcing layer have been made of non-magnetic material.

4. Catheter as claimed in claim 3, wherein the wires of paramagnetic material have been made of an alloy of non-magnetic material and strong paramagnetic material.

5. Catheter as claimed in claim 4, wherein the alloy comprises at least one material from the group including titanium, copper and nickel.

6. Catheter as claimed in claim 1, wherein the element of paramagnetic material consists of a marking ring arranged around the catheter.

7. Catheter as claimed in claim 6, comprising an assembly of two concentric marking rings made of a non-magnetic material visible when subjected to X-rays, and of a paramagnetic material respectively.

8. Catheter as claimed in claim 7, wherein the ring of paramagnetic material has been formed by means

of a deposition technique on the internal surface of the ring made of non-magnetic material.

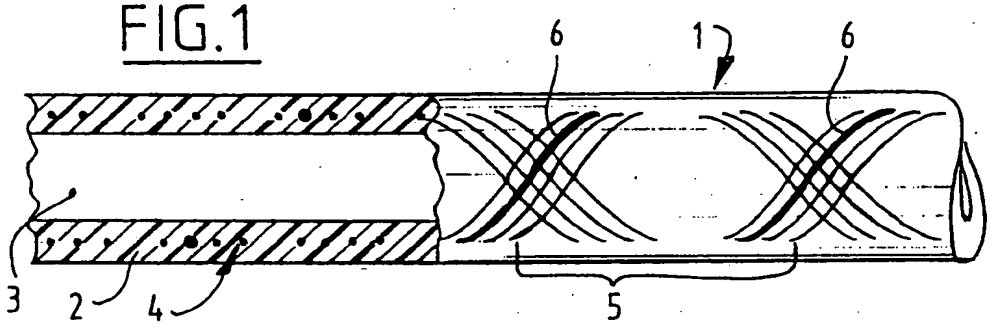
9. Catheter as claimed in claim 8, wherein the deposition technique is a sputter technique.

10. Catheter as claimed in one of the claims 6 - 8, wherein the non-magnetic material visible when subjected to X-rays, comprises at least one material from the group including gold and platinum.

11. Catheter as claimed in claim 2, wherein the element of paramagnetic material is a wire of paramagnetic material wound in a helical fashion and embedded in the material of which the catheter has been made.

12. Catheter as claimed in one of the previous claims, wherein the paramagnetic material has been chosen from the group comprising transition metals such as copper, manganese, chromium, nickel, gadolinium, dysprosium and mixtures, alloys and salts thereof.

FIG.1



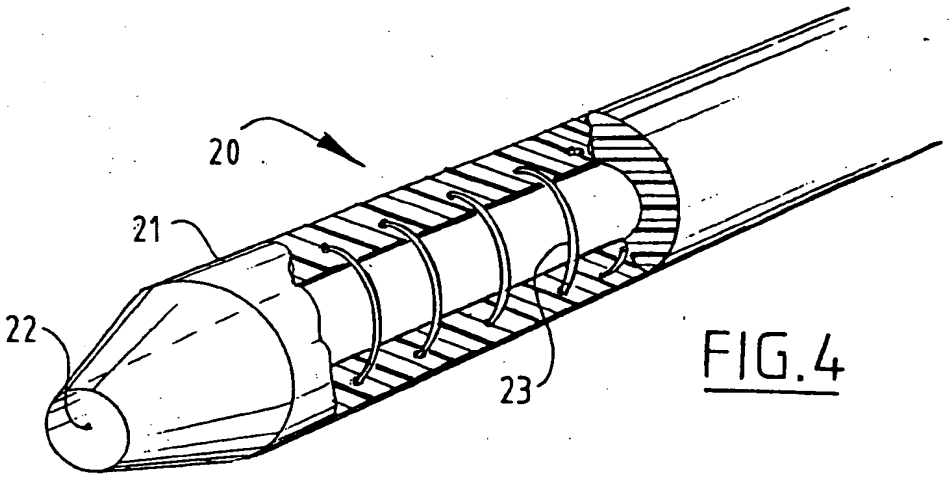


FIG.4

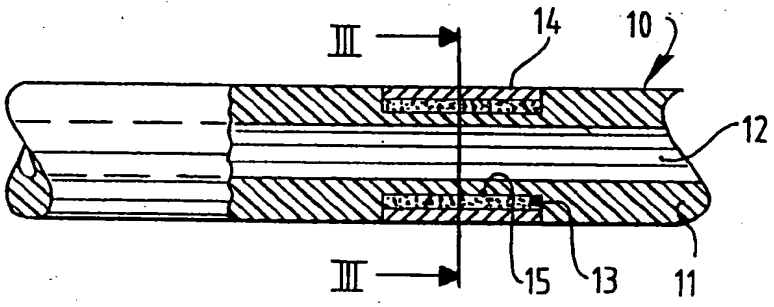


FIG.2

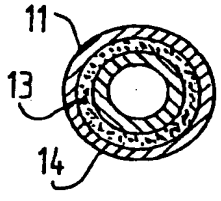


FIG.3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 20 2535

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y,D	US-A-5 154 179 (RATNER) 13 October 1992 * abstract * * column 5, line 58 - column 6, line 41 * * column 8, line 4 - line 6 * * column 9, line 29 - line 32; figures 1-3 * ---	1-12	A61M25/01
Y	WO-A-94 15534 (TARGET THERAPEUTICS, INC.) 21 July 1994 * abstract * * page 2, line 31 - page 3, line 7; claims 1,2,5,6 * -----	1-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) A61M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 December 1995	Michels, N

CATEGORY OF CITED DOCUMENTS

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